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# Economic Valuation of Medicinal Plants Along Socio-Cultural and Agro-Ecological Gradient in Southwestern Ethiopia

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## Abstract

Medicinal plants are vital to both traditional healthcare systems and biodiversity, yet their conservation remains undervalued in economic terms. This study employs the Contingent Valuation Method (CVM) to estimate households' willingness to pay (WTP) for the conservation of medicinal plants, utilizing both double-bound and open-ended follow-up questions. With the help of a multi-stage sampling method, 366 households in Chencha, Arba Minch Zuriya, and Gardula districts were questioned. The analysis utilized an amended probit model, revealing that 89 percent of respondents demonstrated a willingness to pay for the conservation of medicinal plants. The significant predictors of WTP were the level of education, the income of the household, the closeness of one household to the forests, and the bid amount. The average WTP of households was considered to be 3.80 USD per annum, and the total amount of it was calculated to be about 28,890 USD per year within the scope of the study area. These results show the economic and cultural significance of the medicinal plants and the importance of the local communities in terms of sustainable conservation practices. Besides, the research proves that the greater level of education and income, and the proximity of the forest, act as major aids in conservation support. This monetary estimation offers insight to the decision-makers and aids in ensuring the sustainable use of medicinal plant resources, as well as rationalizing the economic understanding of biodiversity conservation.

## Keywords

Conservation; Contingent valuation method; Medicinal plants; Probit Model; Willingness to pay

## Introduction

The long-standing relationship between humans and nature has led to the recognition of the use of medicinal plants since ancient times. Medicinal plants play a crucial role in human well-being, serving as a key element of traditional knowledge and significantly contributing to modern drug production (Salmerón-Manzano, Garrido-Cardenas and Manzano-Agugliaro, 2020). They enhance global biodiversity due to their rich phytochemical and nutritional properties, which promote ecological balance and improve people's health (Howes *et al*., 2020; Prakofjewa *et al*., 2022; Shafi *et al*., 2022; Ostapenko *et al*.,2024). The preservation of health significantly relies on bioactive compounds identified through ethnobotanical and ethnopharmacological research (Akinyemi, Oyewole and Jimoh, 2018; Aslam and Ahmad, 2016). Indeed, medicinal plants also make good trade goods for the worldwide pharmaceuticals markets (Jamshidi-Kia, Lorigooini and Amini-Khoei, 2017). Inregard to climate change, the sustainable use and commercialization of such resources is becoming ever more important (Kurnaz and Kurnaz, 2021).

Medicinal plant conservation is shaped by the sociocultural and environmental settings (Kunwar *et al*., 2022). The works of Laurentino *et al*. (2022), Kunwar *et al*. (2022), and Tamene *et al*. (2024) suggest this. Traditional medicine is the main source of healthcare for the vast majority of people worldwide (Rasool *et al.*, 2020). Kasilo and Nikiema, 2014). More than 90% people in Ethiopia and Burundi rely on traditional medicine. Higher worldwide needs are concerning because of the possibility of exhausting wild resources (Volenzo and Odiyo, 2020). Early research (Chen *et al*., 2022; Volenzo and Odiyo, 2020) suggests that the comparable problem exists in Ethiopia as in other countries.

Evaluation of direct and indirect benefits of medicinal plants is important in arriving at the economic value of the plants (Hanley and Perrings, 2019). Sustainable management involves the combination of cultural traditions with economic incentives and new approaches to conservation (Lamichhane *et al*., 2020; Shafi *et al*., 2021; Chebii, Muthee and Kiemo, 2023; Zhang *et al*., 2023). Likewise, Opalchuk *et al*. (2024) emphasizes that green bonds provide capital for forestry, and land management measures are essential to weather climate change. It is through aligning the local practices with the biotechnological approaches that resource depletion is prevented (Mofokeng *et al*.,2022; Pandey, 2023).

Southwestern Ethiopia has a high level of biodiversity and cultural diversity, and has several ethnic groups that have vast indigenous knowledge on medicinal plants. Such facilities are so crucial in primary healthcare and particularly in rural communities where they can hardly access modern medical healthcare institutions. Nevertheless, this precious knowledge and the plant species that it supports are endangered by deforestation, the exploitation of agricultural lands, and cultural changes, among other factors. The economic worth of these medicinal plants is important to understand conservation planning and sustainable use, which is essential in the conservation of ecological and cultural aspects of the same to benefit future generations.

Multiple studies, including those by Seid (2013), Gandile, Tessema and Nake (2017), Tadesse and Balcha (2018), and Zemede *et al.* (2024), have documented the significant biodiversity and ethnoveterinary practices in various ecosystems. Such works highlight the necessity of conservation through growing threats such as overgrazing, deforestation, and the expansion of agricultural activities. They, however attention to the economic valuation of medicinal plants. Despite the limited availability of such valuation studies, there seems to be a huge research gap. The current study, therefore, presents an opportunity for future research to bridge this gap by incorporating a more holistic approach to understanding the willingness to pay for conservation of medicinal plants within these varied communities. Therefore, this study investigates households willing to pay towards the conservation of medicinal plants and analyzes the factors affecting households' willingness to pay for the conservation of medicinal plant species using the contingent valuation method (CVM) in the Southwest parts of Ethiopia.

## Material and Methods

### *Description of the study area*

The study was carried out in Chencha and Arba Minch Zuriya districts (Gamo Zone) and Gardula Zone in the southwestern Ethiopia, as shown in Figure 1. Chencha is found between 37°29′57″–37°39′36″ E and 6°08′55″–6°25′30″ N with elevations ranging from 1600-3250 m.a.s.l. The region has an average rainfall of 900–1200 mm received in the year and has temperatures ranging from 11–13°C (min) and 18–23°C (max). The Gardula Zone is located at 5°35′25″ N and 37°12′41″ E with the altitudes of 1250-2300 m.a.s.l. The region experiences a moderate tropical highland climate with an average of 601-1600 mm of rainfall and a mean temperature of 27.5 °C (Balemie and Kebebew 2006). In Arba Minch Zuriya, there is Zeyse Elgo, which is located at 5°84′26″ N and 37°46′31.88″ E, whose altitudes range between 1100–1250 m.a.s.l.

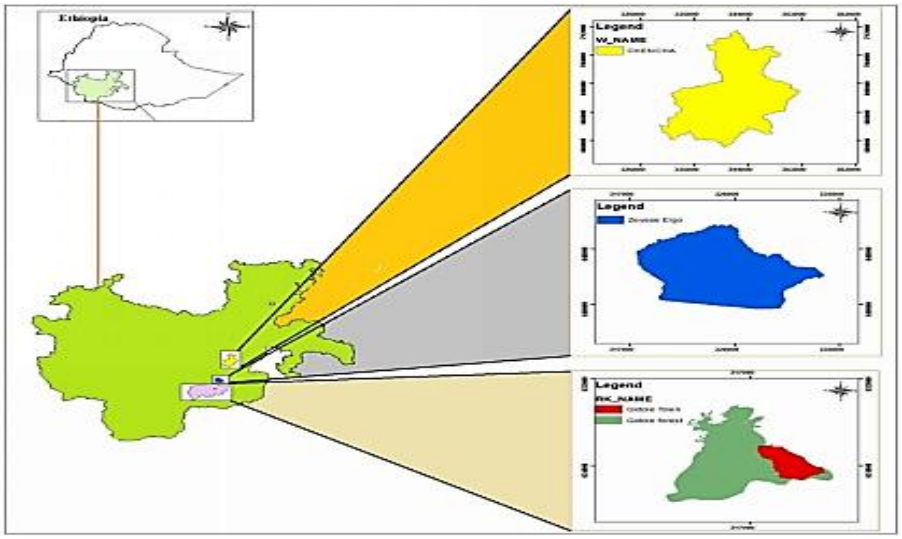


Figure 1: Chencha, Gidole, and Zeyse Elgo Location Map

### *Sampling techniques and sample size determination*

The multi-stage sampling procedure was employed in order to draw sample households. First, the Gamo Zone and Gardula Zone, from the Southern part of Ethiopia, were selected purposively due to the agro-ecological gradient, varied ethnicity, and availability of forests and medicinal plants. Secondly, ten administrative units, or kebeles, were selected from the three districts based on their forest resource potential and the availability of medicinal plants and healers. This selection was conducted using simple random sampling techniques, as demonstrated in table 1.

Table 1: Sampled distribution of households

| *S. No.* | *District* | *Small Administrative Units* | *Total No. of households* | *Sampled household* |
|---|---|---|---|---|
| 1. | Chencha | Ayira | 165 | 8 |
| 2. | | Tutush | 366 | 18 |
| 3. | | Tolola | 1079 | 50 |
| 4. | | Holo | 1136 | 55 |
| 5. | Dherashe | Nalo | 749 | 36 |
| 6. | | LayignawArguba | 715 | 35 |
| 7. | | Siltoya | 635 | 31 |
| 8. | | Harolle | 636 | 31 |
| 9. | | Moro | 501 | 24 |
| 10. | Arba Minch Zuriya | Zeyse Elgo | 1636 | 78 |
| Total | | | 7612 | 366 |

### *Data types, sources, and method of data collection*

This study applied both primary as well as secondary sources of data. A contingent valuation method (CVM) was applied using double-bound and an open-ended follow-up survey question techniques across 366 households selected via a multi-stage sampling process. The questionnaire comprised four sections: The parameters included in this study are: (1) socio-economic characteristics of households, (2) attitudes and knowledge regarding medicinal plant use and conservation, (3) valuation of willingness to pay (WTP) for medicinal plant conservation, and (4) a hypothetical market scenario for value elicitation. Before WTP questions, respondents were given background information on medicinal plants so as to make informed responses. The valuation used a dichotomous choice format of randomly assigned bid values (ETB 50, 100, 150, 200, 250, and 300 per household/year), then an open-ended question to obtain maximum or minimum WTP and reasonably detect starting point bias. Reasons for non-payment were also documented. In addition, qualitative data were obtained from interviews with key informants, comprising development agents and traditional healers, in order to triangulate findings.

### *Economic valuation method*

The study contributed to the willingness of the users to pay (WTP) of households for the conservation of medicinal plants using the DD elicitation format as part of the CVM.

The DD approach supported by the NOAA panel (1993) minimizes non-responses and outliers and makes data reliable as compared with the Single Dichotomous (SD) format. OE and SD questions were also included in triangulating responses and estimating WTP. Bid values were determined from a pilot survey to provide appropriate bounds to the cumulative distribution. CVM, as a stated preference technique, can directly estimate non-market values like environmental goods since it can elicit respondents' WTP for hypothetical conservation scenarios. Collected data were obtained from face-to-face interviews and are known to generate good WTP responses. The process of the survey included: describing the current situation of the medicinal plant resources, presenting a hypothetical market scenario, and then extracting the WTP of the respondents either in monetary terms or through the provision of labor.

### *Empirical model specification*

*Determinants of Households' Willingness to Pay for Medicinal Plants*

The study required looking at the relationship existing between household characteristics and the likelihood of willingness to pay (WTP), offering random initial bid values (cash and labor contributions) for conservation of medicinal plants. Based on a dichotomous choice format under the Contingent Valuation Method (CVM), households could either accept or reject a given bid. A Probit model was applied to do this binary WTP response analysis. Additionally, a two-stage Heckman selection model was used to determine those determinants of WTP in Gamo and Gardula zones of Southwestern Ethiopia, to deal with the possible issues of sample selection bias and generate more robust estimates. The first-stage equation of the Heckman model is a Probit model, which assumes that the errors are homoscedastic.

$y1i = 0$ if $Pni \leq 0$ …… (1)
$y1i = 1$ if
$Pni > 0$…… (2)
Where y1 is the binary response, Pni is the amount of money paid by household i. The payment equation can then be written as:

$y^* 1 = \beta_1 I X_1 I + \varepsilon_1 I$…… (3)
Where $y * 1$ is a latent variable, which is the utility the household will pay for medicinal plants. The binary model is then stated as:

1. If the household pays for medicinal plants …… (4)
0, otherwise

Specifically, the probit model in stage one of estimation is stated as

$Pr(y1) = f(x1, x2, \ldots\ldots\ldots\ldots xn)$ ……5)
where Pr (y1) is the probability of a household deciding to pay for medicinal plants or not, x1, x2,..., xn are the variables specified in Table below (2), and ε is the normally distributed error term.

Table 2: Definition and expected effect of variables

| *Variable* | *Definition of variables* | *Measurement* | *Expected Effect* |
|---|---|---|---|
| WTP | Respondents' willingness to pay for the proposed conservation, dummy variable | 1= Yes 0=No | |
| DIST_FOREST | Distance of the forest from the residence, continuous variable | Hours | +/- |
| HH_SIZE | Household size, continuous variable | Number | - |
| INCOME | Monthly income of the household, continuous | Ethiopian Birr | + |
| MAR_STATUS | Marital status of the respondent, dummy variable | 1=Married 0=otherwise | + |
| EDUC_LEVEL | Education level of the respondent, continuous variable | Years | + |
| AGE | Age of the household head | Years | - |
| GENDER | Sex of the respondent, dummy variable | 1=Male 0=Female | +/- |
| EXT_SERV_MPSC | Extension service of medicinal plants conservation, dummy variable | 1=Yes 0=No | + |
| ACC_MPS_MRKT | Access to the medicinal plants market, dummy variable | 1=Yes 0=No | + |
| AVIL_MPS | Availability of medicinal plants, dummy variable | 1=Yes 0=No | + |
| PART_CMPS | Participation in the conservation of medicinal plants, dummy variable | 1=Yes 0=No | + |
| AWE_MPC | Awareness about medicinal plants conservation, dummy variable | 1=Yes 0=No | + |
| BID | Offered bid price to the respondent, continuous variable | Bid value in Birr | + |

### *Estimation of mean willingness to pay*

Estimating econometric models in WTP surveys involves calculating the mean WTP and allowing the inclusion of respondents' socio-economic factors into WTP functions. According to Hanemann *et al*. (1991), there are four possible outcomes in the double-bounded dichotomous choice elicitation method with their probability:

$B_1 < WTP < B_2$: Pr (Yes; No) = Pr $(\mu_1 + \varepsilon_1 j \geq B_1, \mu_2 + \varepsilon_2 j < B_2)$ ..... (7)
$B_1 > WTP > B_2$: Pr (No; Yes) =Pr $(\mu_1 + \varepsilon_1 j < B_1, \mu_2 + \varepsilon_2 j > B_2$..... (8)
$WTP > B_2$: Pr (Yes; Yes) =Pr $(\mu_1 + \varepsilon_1 j > B_1; \mu_2 + \varepsilon_2 j \geq B_2)$ ..... (9)
$WTP < B_2$: Pr (No; No) =Pr $(\mu_1 + \varepsilon_1 j < B_1, \mu_2 + \varepsilon_2 j < B_2)$ ..... (10)

where $B_1$, $B_2$, and WTP are the initial bid, the second bid amount, and the WTP amount for the follow-up question, respectively. According to Lemi (2015) seemingly unrelated bivariate probit model can be specified as follows:

$Y^*_1 = \alpha_1 + \beta_1 B_1 + \varepsilon_1$ ..... (11)

$Y^*_2 = \alpha_2 + \beta_2 B_2 + \varepsilon_2$ ..... (12)

$Y_1 = 1$ if $Y_1 \geq B_1$

0 if $Y^*_1$ $B_1$

$Y_2 = 1$ if $Y_2 \geq B_2$

0 if $Y^*_2$ $B_2$

*Corr* $(\varepsilon_1; \varepsilon_2 / B_1, B_2) = \rho$

Where $Y_1$ and $Y_2$ are WTP responses for the first and second equations, respectively, B1 and B2 are the bids in the first and second bid questions, α0s and β0s are parameters to be estimated, and ε1 and ε2 are unobservable random components, and ρ is the covariance between the errors for the two WTP functions. Therefore, the mean WTP was calculated by using the coefficients from the constant term and the bids offered. These coefficients were obtained by regressing the dependent variables (WTP1 and WTP2) on the initial and follow-up bid amount, holding other explanatory variables constant (Haab and McConnell, 2002). Thus, the mean WTP was calculated by using the formula:

$$MWTP = -\frac{\alpha}{\beta} \quad \text{..... (13)}$$

Where α is a coefficient for the constant term, and β is a coefficient offered to the respondents.

Then, the aggregate willingness to pay (AWTP) is obtained as follows:

$AWTP = MWTP * THH$ ..... (14),

Where AWTP is the aggregate willingness to pay and THH is the total number of households in the study area.

## Results and Discussion

### *Demographic Characteristics of the Respondents*

Table 3 presents the demographic and economic characteristics of the households surveyed. The ages of respondents ranged from 30 to 75 years old, with an average age of 55. Nearly half (49%) were middle-aged. The majority of households (62%) were led by men, and most (87%) were married. In terms of educational attainment, 39% completed only primary school, 17% were entirely illiterate, and 44% graduated from secondary school. A mere 3% achieved a college degree or higher. Educational levels significantly influence socioeconomic status and awareness of environmental issues.

The survey revealed that 77% of households had a median size of eight members, making this the predominant category. In terms of occupation, 71% of respondents were farmers, while private employees constituted 17% and government employees 11%. Most subjects earned between 6 to 7 thousand birr, with monthly earnings between 1,000 and 10,000 birr. Lower income among larger families meant they had to rely on medicinal plants to increase their income. A further 78% of the respondents understood that medicinal plants are used.

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Table 3: Demographic Characteristics of the Respondents

| *Variables* | *Frequency* | *Percentage (%)* | *Respondent's responses for initial bid* | | *Mean (SD)* |
|---|---|---|---|---|---|
| | | | *WTP%* | *Not WTP %* | |
| Age | | | | | |
| 30-50\| | 113 | 30.87 | 90.0 | 10.0 | |
| 51-63 \| | 181 | 49.45 | 90.97 | 9.03 | 54.17(10.53) |
| >64 \| | 72 | 19.67 | 83.33 | 16.07 | |
| Gender | | | | | |
| Male | 228 | 62.30 | 89.91 | 10.09 | |
| Female | 138 | 37.70 | 87.68 | 12.32 | |
| Marital Status | | | | | |
| Married | 317 | 86.61 | 89.59 | 10.41 | |
| Single | 29 | 7.92 | 86.21 | 13.79 | |
| Divorce | 7 | 1.91 | 100 | - | |
| Widow(er) | 13 | 3.55 | 76.92 | 23.08 | |
| Educational Level | | | | | |
| Illiterate | 61 | 16.67 | 78.69 | 21.31 | |
| Primary Level | 143 | 39.07 | 86.71 | 13.29 | |
| Secondary Level | 93 | 25.41 | 92.47 | 7.53 | |
| Diploma | 58 | 15.85 | 90.91 | 9.09 | |
| Degree and above | 11 | 3.01 | 100 | - | |
| Household size | | | | | |
| 1-4 | 79 | 21.58 | 85.71 | 14.29 | 7.53 |
| 5-8 | 282 | 77.05 | 92.21 | 7.79 | |
| >9 | 5 | 1.37 | 88.30 | 11.70 | |
| Occupation | | | | | |
| Government Employee | 42 | 11.48 | 100 | - | |
| Private Employee | 61 | 16.67 | 86.89 | 13.11 | |
| Farmer | 256 | 70.67 | 87.50 | 12.50 | |
| Casual/Daily Labour | 7 | 1.18 | 87.84 | 12.16 | |
| Income | | | | | |
| <1000Birr | 13 | 3.55 | 92.31 | 7.69 | 6278.14 |
| 1001-2500 Birr | 81 | 22.13 | 79.76 | 20.24 | |
| 2501-5000 Birr | 83 | 22.68 | 91.30 | 8.7 | |
| 5001-10000 Birr | 162 | 44.26 | 95.19 | 4.81 | |
| >10001 Birr | 27 | 7.38 | 81.48 | 18.52 | |
| Awareness about Medicinal Plants | | | | | |
| Yes | 287 | 78.42 | 93.73 | 6.27 | |
| No | 79 | 21.58 | 72.15 | 27.85 | |
| Willingness to Pay for Medicinal Plants Conservation | | | | | |
| Yes | 326 | 89.07 | | | |
| No | 40 | 10.93 | | | |

### *Willingness of respondents for the conservation of medicinal plants*

The study revealed that 89% of respondents expressed a willingness to contribute financially to the conservation of medicinal plants. Among them, 61% indicated a preference for engaging in work alongside financial contributions, while 28% favored monetary payments exclusively. The benefits to vendors encompass protective measures

for nature (29%), services for nature (11%), advancements in the medical and pharmaceutical sectors (6%), and enhancements in market conditions (44%). This is consistent with findings from studies that show the community is in favor of conservation (Mamboleo and Adem, 2022, 2023; Waruingi *et al*., 2022; Wassihun, 2021; Kassahun and Taw, 2022). Similar patterns have been observed in Ethiopia (Asmare, Bekele and Fentaw, 2022). Local studies (Abebe *et al.*, 2023; (Asado, Adicha and Tesfaye, 2022) and global research (Attaeian *et al.*, 2023; Nsibanyoni, Tsvakirai and Makgopa, 2023) indicate that perceived value and robust community support are essential for the success of biodiversity initiatives. In addition, indigenous environmental knowledge can support sustainability, finding from indigenous environmental knowledge of Borana pastoralists is vital to ensure their usefulness in justifiable natural resource management (Alemayehu, and Doda, 2020).

Households' decisions to accept or reject conservation bids were influenced by various demographic, socioeconomic, and institutional factors. Among the 11% of respondents unwilling to pay, 45% viewed medicinal plant conservation as solely the government's responsibility, while 27% cited financial constraints. Additionally, 18% lacked trust in the effectiveness of the proposed conservation measures, and 10% were pleased with existing practices. Notably, 3% of the total respondents fell under the protest "No–No" category, indicating firm refusal to support the initiative.

Table 4: Reason for rejecting the offered bid

| *Reason for not being willing to pay for the conservation of medicinal plants* | *Frequency* | *Percent (%)* |
|---|---|---|
| I do not have enough income to pay | 3 | 27.28 |
| I think the government should finance the program | 5 | 45.45 |
| I do not believe the program will result in more reliable, improved medicinal plant conservation | 2 | 18.18 |
| I am satisfied with current conservation practices | 1 | 9.09 |
| Total | 11 | 100 |

### *Joint Response to proposed bids*

Respondents were grouped upon their response to initial and follow-up bids. 53% accepted both (Yes-Yes), 33% accepted the initial but rejected the follow-up (Yes-No), 3% rejected the initial but accepted the follow-up (No-Yes), and 11% rejected both (No-No). The high acceptance rate reflects a high level of community commitment to the conservation of medicinal plants, being subjected to the influence of the cultural and socioeconomic factors.

Related with this study, a substantial number of Herbal Medicine Practitioners and Vendors in Nigeria were willing to contribute financially to conservation projects, as determined by (Ajewole, Oladele and Ogunwale, 2014). One of the aspects mentioned by (Chebii, Muthee and Kiemo, 2023) was the extensive readiness to pay for medicinal plant conservation, which means that more and more people realize the need to preserve biodiversity and traditional learning.

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Table 5: Joint response to the offered bids

| *Variable* | *Frequency* | *Percent* |
|---|---|---|
| Yes-Yes | 193 | 52.73 |
| Yes-No | 122 | 33.33 |
| No- Yes | 11 | 3.01 |
| No- No | 40 | 10.93 |
| Total | 366 | 100 |

### *Estimation of Mean Willingness to Pay*

To analyse the WTP, the probit model was estimated by using response dummy variables for the following responses and with their respective bid amounts to assess the determinants of people's preference for and to estimate the average willingness to pay for medicinal plants conservation. Table 6 shows the probit model results of the willingness to pay questions. The goodness of fit for the regression is given by the Pseudo R-Square of 0.725 and is significant at 1% level. The incidence of multicollinearity is tested, and the result showed that the value of the variance inflation factor for the continuous variables was less than 5, indicating there is no multicollinearity among the independent variables. Both the coefficients and marginal effects of the probit model are given in table 6.

Table 6: Probit Model Parameter Estimates

| *WTP* | *Coef.* | *St.Err.* | *t-value* | *p-value* | *dy/dx* |
|---|---|---|---|---|---|
| Dist_forest | .341 | .172 | 1.98 | .048** | 0.018 |
| Stay_Area | -.019 | .194 | -0.10 | .923 | -0.002 |
| Hh_Size | -.041 | .412 | -0.10 | .921 | -0.002 |
| Income | .473 | .202 | 2.34 | .019** | 0.024 |
| Occup | -.396 | .262 | -1.51 | .131 | -0.020 |
| Mar_status | .192 | .375 | 0.51 | .609 | 0.010 |
| Educ_level | .476 | .212 | 2.24 | .025** | 0.027 |
| Age | -.267 | .252 | -1.06 | .29 | -0.013 |
| Gender | -.277 | .382 | -0.72 | .469 | -0.012 |
| Ext_Serv_Mpsc | -.151 | .365 | -0.41 | .678 | - 0.006 |
| Acc_Mps_Mrkt | .225 | .372 | 0.60 | .545 | 0.010 |
| Avil_Mps | .171 | .454 | 0.38 | .706 | 0.009 |
| Part_CMps | .554 | .386 | 1.44 | .151 | 0.029 |
| Awe_MPc | 1.045 | .383 | 2.73 | .006*** | 0.053 |
| Initial bid | 3.709 | .52 | 7.13 | 000*** | 0.186 |
| Constant | .017 | 2.074 | 0.01 | .993 | |
| Mean dependent var | 0.891 | | SD dependent var | 0.312 | |
| Pseudo r-squared | 0.725 | | Number of obs | 366 | |
| Chi-square | 183.212 | | Prob> chi2 | 0.000 | |
| Akaike crit. (AIC) | 101.348 | | Bayesian crit. (BIC) | 163.790 | |

*** $p<.01$, ** $p<.05$, * $p<.1$ Source: Own survey result,2023

### *Determinants of a household's WTP decision*

*Distance from home to the forest*: The results revealed that people are less willing to pay to conserve the forest as the distance from it grows. Those living far from the forest think

they do not benefit as much, leading to lower conservation participation (Getachew, 2018; Asmare, Bekele and Fentaw, 2022). It points to the importance of directing policies based on locations.

*Education of household head:* At the 5% significance level, education has a significant and positive impact on a household's willingness to pay. Specifically, an additional year of education increases the likelihood of accepting the bid by 2.7%, with other factors held constant. As a result, it is more likely that household heads who are educated will recognize the importance of saving medicinal plants. The outcome from the study is supported by studies carried out in India and Ethiopia (Bhat and Sofi, 2021). According to Abebe *et al*. (2023), and Bedilu *et al*. (2023), education has a positive impact on how people protect nature.

*Household Income:* Household income was found to have a positive and statistically significant impact on people's reasons for purchasing medicinal plants at the 5% level. With a 1-birr rise in annual income, the odds of bidding acceptance went up by 2.4%, keeping other variables the same. This agrees with what was found by Abebe *et al*. (2023) in Ethiopia and Mamboleo and Adem (2023) in Kenya that income is very important for deciding if someone will support conservation.

*Awareness about Medicinal Plants Conservation:* Awareness of medicinal plant benefits significantly increased willingness to pay (WTP) for their conservation at the 1% level, with a 5% higher likelihood of influence among more aware households, holding other factors constant. (Asmare, Bekele and Fentaw, 2022) found support for this idea by showing that factors like awareness benefit the willingness to pay for wetland rehabilitation. It proves that being aware of the problem is crucial for improving how communities take part in conservation activities. Hrei *et al*. (2024) states environmental issues are becoming more pressing, demand collective efforts and a shift in societal thinking to reduce pollution levels and preserve biodiversity.

*Initial bid:* The amount of the initial bid affected WTP positively and was statistically significant at the 1% level, with every Birr raise making the person less likely to accept by 1.86%. So, a higher bid amount makes it less likely that households are interested in protecting medicinal plants. An influence on initial bids on conservation support was also found by Drucker *et al*. (2023) in Malawi and (Liordos, Antoniadou and Kontsiotis, 2023) in Greece.

### *Aggregate welfare gains from the conservation intervention*

According to Hanemann (1991), estimating empirical WTP based on the CV survey response is to derive the central value (mean) of the WTP distribution (Hanemann, Loomis and Kanninen, 1991).

Mean WTP =$\mu = \sigma/\beta = 3.709/0.017 = 218.17$

The analysis revealed that the mean willingness to pay (WTP) derived from the closed-ended format was 218.17 birr (approximately 3.80 USD) per year for the proposed conservation and management of medicinal plants. The aggregate willingness to pay

(WTP) was calculated by multiplying the average WTP by the number of households benefiting from forest resources across the three sites. This metric gauges the collective benefit derived from an improved and abundant supply of medicinal plants (Haab and McConnell, 2002). Such techniques sum up the advantages that the intervention brings to the community level (Flores, 2017).

Then,
The aggregate willingness to pay can be estimated as:
= 218.17 × 7612 = 1,660,710.04

Thus, the aggregate yearly WTP by all households for the study area was 1,660,710.04 birr per year (28,890.69USD).

Some studies have shown the average amount people are willing to pay for nature preservation. Mamboleo and Adem (2022) found that the average WTP in Kenya's Lake Victoria Basin was KES 500, and Bhat and Sofi (2021) found people in Danchigam were willing to pay Rs 245.57 for biodiversity each year. Entrance to Qinling National Park in China costs 200 Yuan per person, as reported by Song *et al*. (2021). In the country, it is estimated that the Wof-Washa forest can generate 1.7 million ETB, soil and water conservation 1,336,873 ETB, the Meteka wetland 535,922.88 ETB, and restoration of Lake Ziway costs USD 21–31 (Asmamaw *et al*., 2017; Getachew, 2018; Girma *et al*., 2021; Kassa and Teshome, 2015). These results indicate that conservation is valued by the communities themselves in economic terms.

This study shows that it is important to work with people living in the community for conservation efforts. The purpose of this research is to fill a gap in valuation research by recognizing how traditional healers and communities conserve medicinal plants. As it is the first of its kind in economic valuation of medicinal plants, it provides useful data that can guide the creation of long-term policies and conservation measures. This research links the assessment of environmental valuation to the conservation of medicinal plants to ensure future generations have access to a rich variety of natural products. It is necessary to tie economic valuation to conservation methods to promote sustainable living and make traditional healers' lives better by focusing on the economy of medicinal plants (Shukla, 2023). The valuation measures the public's willingness to support conservation efforts.

As in the previous willingness-to-pay studies, Abebe *et al*. (2019) have conducted similar willingness-to-pay (WTP) studies (Diriba, 2022; Fitsum, Senbeta and Guta, 2021). This way of looking at spending shows the highest amount people can afford and the effects of income and access to resources. Even without a specific WTP study, the fact that medicinal plants are part of Ethiopia's traditional care system suggests that most people would gladly contribute to protect them. There is a requirement for further work to accurately measure this impact, so full conservation plans can be put in place.

## Conclusion

The study highlights valuable understandings regarding the socio-economic characteristics of households and their willingness to pay for medicinal plants'

conservation. The results show that households highly prefer to contribute towards conservation, and a majority prefer 89% to contribute to conservation activities on medicinal plants. Income levels, educational attainment, and distance from the forest are some of the determinants of the willingness to pay. Mean WTP for interventions to conserve medicinal plants is 3.80 USD per year, with an aggregate value estimated at 28,890.69 USD annually. Education is critical in influencing the knowledge and understanding of environmental issues and the conservation of natural resources by people. The reasoning indicates that the role of households is significant in the management and conservation of medicinal plants. It shows that conservation should not be considered merely a governmental or organizational responsibility; rather, it should be classified as a collaborative effort where each household has a vital place. The ownership and responsibility to conserve medicinal plants, as reflected in the willingness to pay, could set off a thrust toward sustainable conservation practices. The other issue is the one from the perspective of conserving medicinal plants. Understanding the variables that shape willingness to pay will help design an effective mechanism for economic development and conservation strategies. The high acceptance of the initial bids indicates a rise in public awareness and commitment to conserving the environment. Threats to this resource, such as habitat destruction, emphasize the need for further efforts towards its conservation and sustainable use. The study presents a monetary estimate, which aids decision makers in better managing and protecting medicinal plants, contributing to current economic knowledge of medicinal plant conservation, and laying the basis for subsequent studies.

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## Authors' Declarations and Essential Ethical Compliances

*Authors' Contributions (in accordance with ICMJE criteria for authorship)*

| *Contribution* | *Author 1* | *Author 2* | *Author 3* | *Author 4* | *Author 5* |
|---|---|---|---|---|---|
| Conceived and designed the research or analysis | Yes | Yes | Yes | Yes | No |
| Collected the data | Yes | No | Yes | No | Yes |
| Contribution to data analysis and interpretation | Yes | Yes | Yes | Yes | Yes |
| Wrote the article/paper | Yes | Yes | No | No | Yes |
| Critical revision of the article/paper | Yes | Yes | Yes | Yes | Yes |
| Editing the article/paper | Yes | Yes | Yes | Yes | Yes |
| Supervison | No | Yes | Yes | Yes | Yes |
| Project administration | Yes | Yes | Yes | Yes | No |
| Funding acquisition | Yes | Yes | Yes | Yes | No |
| Overall contribution proportion (%) | 20 | 20 | 20 | 20 | 20 |

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*Research involving human bodies or organs or tissues (Helsinki Declaration)*
The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

*Research involving animals (ARRIVE Checklist)*
The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. The contexts of animals were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

*Research on Indigenous Peoples and/or Traditional Knowledge*
The author(s) solemnly declare(s) that this research has not involved Indigenous Peoples as participants or respondents. The contexts of Indigenous Peoples or Indigenous Knowledge were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or prior informed consent (PIC) of the respondents or Self-Declaration in this regard does not apply in cases of this study or written work.

*Research involving Plants*
The author(s) solemnly declare(s) that this research has not involved the plants for experiment and field studies. Some contexts of plants are also indirectly covered through literature review. Thus, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

*Research Involving Local Community Participants (Non-Indigenous) or Children*
The author(s) solemnly declare(s) that this research has directly involved local community participants or respondents belonging to non-Indigenous peoples. This study did not involve any child in any form directly. The contexts of different humans, people, populations, men/women/children and ethnic people were only indirectly covered through literature review. Therefore, a prior informed consent (PIC) of the respondents or Self-Declaration in this regard is appended.

*PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)*
The author(s) has/have NOT complied with PRISMA standards. It is not relevant in case of this study or written work.

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During the preparation of this work, the authors have used AI to assists the script translation and proof reading. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Declarations] from the published Abstract page accessible through and linked with the DOI: https://doi.org/10.33002/nr2581.6853.080245.

**INFORMATION AND CONSENT FORM FROM RESPONDENTS**
**(Non-Indigenous Respondents)**
*This form was translated into local language for the respondents*

# Title of the Research: Economic Valuation of Medicinal Plants Along Socio-Cultural and Agro-Ecological Gradient in Southwestern Ethiopia


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- Dawit Woubishet (PhD, Associate Researcher)
Environment and Climate Research Center, Policy Studies Institute (ECRC/PSI), Addis Ababa, Ethiopia.


## A) INFORMATION TO PARTICIPANTS

### 1. Objectives of the research

The objectives of this study were to investigates households willing to pay towards the conservation of medicinal plants and analyzes the factors affecting households' willingness to pay for the conservation of medicinal plant species-along socio-cultural and agro-ecological gradient in Southwestern Ethiopia .

### 2. Participation in research

The researcher will ask you several pertinent questions. This interview will be recorded in written form and should last about 50-60 minutes. The location and timing of the interview will be determined by you, depending on your availability and convenience.

### 3. Risks and disadvantages

There is no particular risk involved in this project. You may, however, refuse to answer any question at any time or even terminate the interview.

### 4. Advantanges and benefits

You will receive intangible benefits even if you refuse to answer some questions or decide to terminate the interview. You will also contribute to better understanding of willingness to pay for conservation of medicinal plants helps reveal perceived economic and cultural value, guiding sustainable medicinal plant management and policy decisions.

### 5. Confidentiality

Personal information you give us will be kept confidential. No information identifying you in any way will be published. In addition, each participant in the research will be assigned a code and only the researcher will know your identity.

## 6. Right of withdrawal

Your participation in this project is entirely voluntary and you can at any time withdraw from the research on simple verbal notice and without having to justify your decision, without consequence to you. If you decide to opt out of the research, please contact the researcher at the telephone number or email listed below. At your request, all information concerning you can also be destroyed. However, after the outbreak of the publishing process, it is impossible to destroy the analyses and results on the data collected.

## B) CONSENT

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**Declaration of the participant**

- ⇨ I understand that I can take some time to think before agreeing or not to participate in the research.
- ⇨ I can ask the research team questions and ask for satisfactory answers.
- ⇨ I understand that by participating in this research project, I do not relinquish any of my rights, including my right to terminate the interview at any time.
- ⇨ I have read this information and consent form and agree to participate in the research project.
- ⇨ I agree that the interviews be recorded in written form by the researcher: Yes ( ) No ( )

Signature of the participant : _____ Date : _____

Surname : _____ First name : _____

**Researcher engagement**

I explained to the participant the conditions for participation in the research project. I answered to the best of my knowledge the questions asked and I made sure of the participant's understanding. I, along with the research team, agree to abide by what was agreed to in this information and consent form.

Signature of the researcher : Date : 04-09-2024

Surname: Gebreyesus First name:Kalkidan

- ⇨ Should you have any questions regarding this study, or to withdraw from the research, please contact Mrs. Kalkidan Tadele Gebreyesus by e-mail: tadelekalkidan6@gmail.com
- ⇨ If you have any concerns about your rights or about the responsibilities of researchers concerning your participation in this project, you can contact Shibru, South Ethiopia, Arba Minch University, Arba Minch, Ethiopia by email: simonshibru@yahoo.com